Oxford Dendrochronology Laboratory
Report 2011/22

THE TREE-RING DATING OF CWM FARM CWM CYNFAL FFESTINIOG, GWYNEDD (NGR SH 733 412) NPRN 28320

Summary

Eleven timbers were sampled from various elements of the building. Three samples, all from principal rafters, were found to have been derived from the same tree. These, along with all except one of the other samples appear to form a single group of trees. A wallplate retained complete sapwood and was felled in **Summer 1523**, and most likely dates the trusses. Two other samples also had complete sapwood. In one, a screen head beam, this had become detached, and it is possible that one or two years of sap were lost, the felling date is therefore given as **1533–35**, the other, a fire place lintel, had complete sapwood, but with very narrow outer rings the exact number of rings was uncertain, and the felling date is therefore given as ***c*1535.** One other timber, also a principal rafter, was felled in **winter 1567/68.** The context suggests this is a repair.

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The Tree-Ring Dating of Cwm Farm, Cwm Cynfal, Ffestiniog, Gwynedd (NGR SH 733 412)

BACKGROUND TO DENDROCHRONOLOGY

The basis of dendrochronological dating is that trees of the same species, growing at the same time, in similar habitats, produce similar ring-width patterns. These patterns of varying ring-widths are unique to the period of growth. Each tree naturally has its own pattern superimposed on the basic 'signal', resulting from genetic variations in the response to external stimuli, the changing competitive regime between trees, damage, disease, management etc.

In much of Britain the major influence on the growth of a species like oak is, however, the weather conditions experienced from season to season. By taking several contemporaneous samples from a building or other timber structure, it is often possible to cross-match the ring-width patterns, and by averaging the values for the sequences, maximise the common signal between trees. The resulting 'site chronology' may then be compared with existing 'master' or 'reference' chronologies.

This process can be done by a trained dendrochronologist using plots of the ring-widths and comparing them visually, which also serves as a check on measuring procedures. It is essentially a statistical process, and therefore requires sufficiently long sequences for one to be confident in the results. There is no defined minimum length of a tree-ring series that can be confidently cross-matched, but as a working hypothesis most dendrochronologists use series longer than at least fifty years.

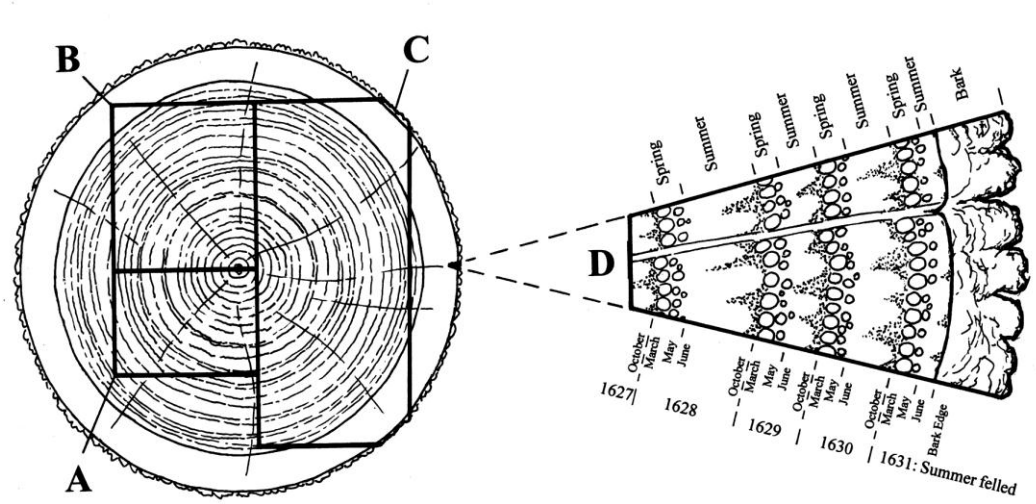
The dendrochronologist also uses objective statistical comparison techniques, these having the same constraints. The statistical comparison is based on programs by Baillie & Pilcher (1973, 1984) and uses the Student's *t*-test. The *t*-test compares the actual difference between two means in relation to the variation in the data, and is an established statistical technique for looking at the significance of matching between two datasets that has been adopted by dendrochronologists. The values of '*t*' which give an acceptable match have been the subject of some debate; originally values above 3.5 being regarded as acceptable (given at least 100 years of overlapping rings) but now 4.0 is often taken as the base value. It is possible for a random set of numbers to give an apparently acceptable statistical match against a single reference curve – although the visual analysis of plots of the two series usually shows the trained eye the reality of this match. When a series of ring-widths gives strong statistical matches in the same position against a number of independent chronologies the series becomes dated with an extremely high level of confidence.

One can develop long reference chronologies by cross-matching the innermost rings of modern timbers with the outermost rings of older timbers successively back in time, adding data from numerous sites. Data now exist covering many thousands of years and it is, in theory, possible to match a sequence of unknown date to this reference material.

It follows from what has been stated above that the chances of matching a single sequence are not as great as for matching a tree-ring series derived from many individuals, since the process of aggregating individual series will remove variation unique to an individual tree, and reinforce the common signal resulting from widespread influences such as the weather. However, a single sequence can be successfully dated, particularly if it has a long ring sequence.

Growth characteristics vary over space and time, trees in south-eastern England generally growing comparatively quickly and with less year-to-year variation than in many other regions (Bridge, 1988). This means that even comparatively large timbers in this region often exhibit few annual rings and are less useful for dating by this technique.

When interpreting the information derived from the dating exercise it is important to take into account such factors as the presence or absence of sapwood on the sample(s), which indicates the outer margins of the tree. Where no sapwood is present it may not be possible to determine how much wood has been removed, and one can therefore only give a date after which the original tree must have been felled. Where the bark is still present on the timber, the year, and even the time of year of felling can be determined. In the case of incomplete sapwood, one can estimate the number of rings likely to have been on the timber by relating it to populations of living and historical timbers to give a statistically valid range of years within which the tree was felled. For this region the estimate used is that 95% of oaks will have a sapwood ring number in the range 11 – 41 (Miles 1997a).



Section of tree with conversion methods showing three types of sapwood retention resulting in **A** *terminus post quem*, **B** a felling date range, and **C** a precise felling date. Enlarged area **D** shows the outermost rings of the sapwood with growing seasons (Miles 1997, 42)

CWM FARM

This is a stone-walled house with collar-beam and tie-beam trusses and a cross-passage doorway of distinctive Snowdonian type with a head of voussoirs. The house was conceived as a three-unit hall-house of 'gentry' type with a central arch-braced truss in the two-bayed

hall. A two-door dais partition of post and-panel type survives with a canopy and evidence for a dais bench. The central truss has cusped principals and there are cusped windbraces. Both the dais partition and the arch-braced truss have a distinctive nail head ornament punctuating the chamfers at intervals.

The central arch-braced truss is embedded in the hall chimney, showing that the fireplace is an insertion.

SAMPLING

Sampling took place in March and July 2011. All the samples were of oak (*Quercus* spp.). Core samples were extracted using a 15mm diameter borer attached to an electric drill. They were numbered using the prefix **cwm**. The samples were removed for further preparation and analysis. Cores were mounted and then polished using progressively finer grits down to 400 to allow the measurement of ring-widths to the nearest 0.01 mm. The samples were measured under a binocular microscope on a purpose-built moving stage with a linear transducer, attached to a desktop computer. Measurements and subsequent analysis were carried out using DENDRO for WINDOWS, written by Ian Tyers (Tyers 2004).

RESULTS AND DISCUSSION

Details of the samples, and their locations, are given in Table 1, and illustrated in Figure 1.

Two timbers had second cores extracted in the second visit – samples **01** and **11**. In the case of **cwm01b**, complete sapwood was present, but the outer section had become detached at about the same place as the outer edge of the first sample. One could not be certain if one or two rings may have been lost at this break point, and the felling date range is therefore given a small range of years. In the case of **cwm11**, the fireplace lintel, complete sapwood was retained, but the outer rings were so narrow in places that the exact ring count could not be completely certain. Both pairs of ring sequences were combined for further analyses.

Cross-matching between the samples (Table 2) and comparisons of the plots of the ring-width series revealed that three timbers (**03**, **05** and **07**) – all principal rafters, were almost certainly derived from the same tree. These three series were combined into a single series **cwm357** for subsequent analysis. Sample **cwm09** – another principal rafter, did not match the other series well, but was dated independently (Table 3a). When added into the site chronology however, it did strengthen the overall matching values (shown in Table 3b).

The relative positions of overlap of the dated sequences are shown, along with the interpreted or actual felling dates, in Figure 2. One timber, a wallplate, retained complete sapwood was felled in **summer 1523**, but two others, a screen head beam and a fireplace lintel, were found to have been felled in the **mid-1530s**. Tree-ring dating has therefore established that the fireplace of *c*1535 is very nearly contemporary with the trusses. Nevertheless, the trusses are clearly primary and the sequence seems to be:

1. Hallhouse *c*1523. Wallplate 1523 falls within the date range of the trusses (1503-33). The first floor corbelled fireplace (with stock-piled lintel?) falls within this phase (Richard Suggett, pers comm.).

2. Inserted fireplace *c*1535. The screen also belongs to this phase and is part of the second phase improvement of the house.

3. 1567/68 Repair phase. One of the principal rafters of the outer-room truss (truss 3) has been replaced. The upper-end stone stair may belong to this phase and the creation of a lobby entrance superseding the cross-passage.

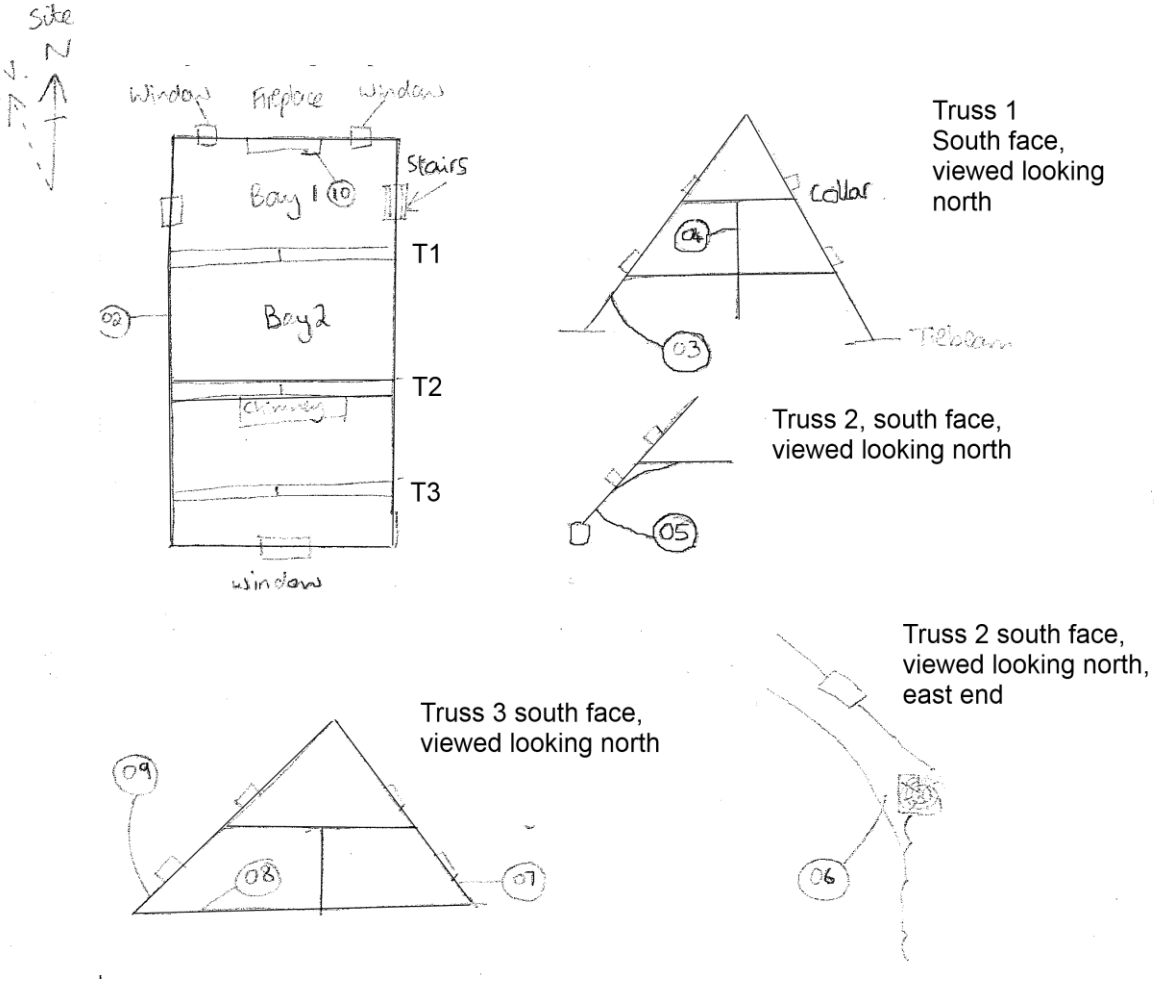


Figure 1: Field sketch of sampling positions (from an original by Matt Hurford).

ACKNOWLEDGEMENTS

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Table 1: Details of samples taken from Cwm Farm.

Sample number	Timber and position	Date of series	H/S boundary date	Sapwood complement	No of rings	Mean width mm	Std devn mm	Mean sens	Felling date range
cwm01a	Screen head beam	*1375-1497*	*1492*	*5 (+3NM)*	*123*	*1.53*	*0.75*	*0.25*	
cwm01b	*ditto*	*1404-1504*	*1500*	*4(+c27C NM)*	*101*	*1.40*	*0.50*	*0.29*	
*** cwm01**	Mean of **01a** and **01b**	1375-1504	1500	4(+27C NM)	130	1.57	0.73	0.25	*c*1533–35
*** cwm02**	West wall plate, bay 2	1377-1522	1485	37½C	146	0.85	0.53	0.27	Summer 1523
cwm03	West principal rafter, truss 1	1404-1497	1496	1	94	1.41	0.57	0.26	1507–1537
*** cwm04**	Crown strut, truss 1	1400-1500	1498	2	101	1.50	0.73	0.27	1509–1539
cwm05	West principal rafter, truss 2	1364-1439	-	-	76	2.81	1.18	0.21	After 1450
cwm06a	East principal rafter, truss 2	*1419-1474*	-	-					
cwm06b	*Ditto*	*1401-1513*	*1501*	*12*					
*** cwm06**	Mean of **06a** and **06b**	1401-1513	1501	12	113	1.91	1.10	0.31	1514–1542
cwm07	East principal rafter, truss 3	1397-1501	1488	13	105	1.50	0.45	0.25	1502–1529
*** cwm08**	Tiebeam, truss 3	1417-1491	1491	H/S	75	1.41	0.63	0.24	1502–1532
*** cwm09**	West principal rafter, truss 3	1421-1567	1541	26C	147	1.42	0.77	0.19	Winter 1567/68
*** cwm10**	Fireplace lintel, 1st Flr, N gable end	1399-1472	1470	2 (+28NM)	74	1.86	1.01	0.20	1500–1511
cwm11a	*South fireplace lintel, GFlr, S end*	*1415-1469*	-	-	*55*	*4.23*	*1.19*	*0.24*	
cwm11b	*ditto*	*1430-1482*	*c1490*	*+c45NM*	*53(+8NM)*	*2.08*	*0.55*	*0.24*	
*** cwm11**	Mean of **11a** and **11b**	1415-1482	*c1490*	+*c*45NM	68(+8NM)	3.09	1.06	0.25	*c*1535
*** cwm357**	Mean of **03** + **05** + **07**	1364-1501	**1492**	**H/S**	**138**	**2.07**	**1.16**	**0.22**	**1503-1533**
***** = included in site master **CWMFM**		**1364-1567**			**204**	**1.67**	**0.90**	**0.19**	

Key: H/S bdry = heartwood/sapwood boundary - last heartwood ring date; C = complete sapwood, winter felled; ½C = complete sapwood, felled the following summer; std devn = standard deviation; mean sens = mean sensitivity; NM = not measured.

Table 2a: Cross-matching between dated samples from Cwm Farm

Sample	cwm02	cwm03	cwm04	cwm05	cwm06	cwm07	cwm08	cwm09	cwm10	cwm11
cwm01	3.4	7.6	5.9	6.4	9.6	9.1	6.5	0.9	5.3	5.4
cwm02		2.2	3.0	3.6	4.4	2.3	2.9	0.1	3.8	2.7
cwm03			4.3	**9.5**	6.2	**16.4**	4.1	2.8	2.2	4.1
cwm04				4.3	4.9	4.6	3.4	1.2	3.5	5.8
cwm05					5.3	**12.5**	3.6	*	2.7	4.6
cwm06						6.4	6.4	2.4	6.0	4.4
cwm07							5.1	2.6	2.4	3.6
cwm08								2.8	5.3	4.1
cwm09									1.1	0.0
cwm10										5.5

* = less than 25 years overlap, figures in **bold** indicate same tree matches. Figures in blue indicate consistently non-significant matches.

Table 3a: Dating evidence for the site sequence **cwm09** **AD 1421–1567** against dated reference chronologies, regional chronologies in **bold**

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
Wales	Kerry Church	(Miles *et al* 2011)	KERRY	1402-1567	147	7.9
Wales	Welsh Master Chronology	(Miles 1997)	**WALES97**	404-1981	147	7.3
Wales	Rose and Crown, Gwydwn	(Miles and Worthington 2000)	GWYDWN	1411-1571	147	7.1
Shropshire	Brookgate Farm	(Miles and Haddon-Reece 1993)	BROOKGT	1362-1611	147	6.6
Wales	Branas-Uchaf, Llandrillo	(Miles *et al* 2010)	DENBY6	1388-1763	147	6.6
Shropshire	Shropshire Master Chronology	(Miles 1995)	**SALOP95**	881-1745	147	6.3
Wales	Neuadd Cynhinfa Pontrobert	(Miles and Haddon-Reece 1996)	neu1	1438-1506	69	6.1
Wales	Tydynn Lwydion	(Miles and Haddon-Reece 1996)	TYDDYN	1385-1601	147	6.0
Shropshire	14 Callaughton, Much Wenlock	(Miles and Worthington 1997)	CALLGHTN	1335-1569	147	6.0

Table 3b: Dating evidence for the site master **CWMFM1** **AD 1364–1567** against dated reference chronologies, regional chronologies in **bold**

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
Wales	Pengwern Old Hall	(Miles *et al* 2003)	PENGWERN	1353-1521	158	13.2
Wales	Bodwrda, Aberdaron	(Miles *et al* 2010)	LYNA	1384-1527	144	9.5
Wales	Bryn yr Odyn, Gwynedd	(Miles *et al* 2010)	BRYNRDYN	1388-1586	180	8.8
Wales	Plas y Dduallt, Maentwrog	(Miles *et al* 2011)	GWYNEDD5	1355-1604	204	8.8
Wales	Bwthyn Cae-glas, Llanfrothen	(Miles *et al* 2006)	BDGLRT7	1386-1547	162	8.4
Wales	Pant-glas-uchaf, Clynnog	(Miles *et al* 2006)	BDGLRT14	1413-1573	155	8.0
Wales	Welsh Master Chronology	(Miles 1997b)	**WALES97**	404-1981	204	7.8
Wales	Newton Nottage Church	(Miles *et al* 2004)	NWTNNTTG	1362-1535	172	7.4
Wales	Beddgelert	(Nayling pers comm)	BEDD_T6	1302-1529	166	7.3
Wales	Parc Llanfrothen	(Miles *et al* 2006)	BDGLRT22	1386-1669	182	7.3
Wales	Derwyn-bach, Dobenmaen	(Miles *et al* 2006)	BDGLRT15	1385-1548	164	7.2
Cumbria	Dacre Hall	(Arnold *et al* 2004)	LCPASQ01	1350-1504	141	7.2
Wales	Cae'nycoed-uchaf, Maentwrog	(Miles *et al* 2006)	BDGLRT17	1407-1592	161	7.0
Wales	Gelli, Llanfrothen	(Miles *et al* 2006)	BDGLRT8	1391-1662	177	7.0
Wales	Y Gesail Gyfarch, Dolbenmaen	(Miles *et al* 2006)	BDGLRT6	1384-1609	184	6.7
Ireland	Belfast Master Chronology	(Baillie 1977)	**BELFAST**	1001-1970	204	6.7
Wales	St Gwyddelan's Church, Dolwyddelan	(Miles *et al* 2011)	STGWYD	1360-1467	104	6.6
Wales	Royal House, Machynlleth	(Miles *et al* 2004)	ROYALHS1	1363-1560	197	6.6
Wales	60 Castle Street, Beaumaris	(Miles *et al* 2011)	ANGK	1391-1515	125	6.6

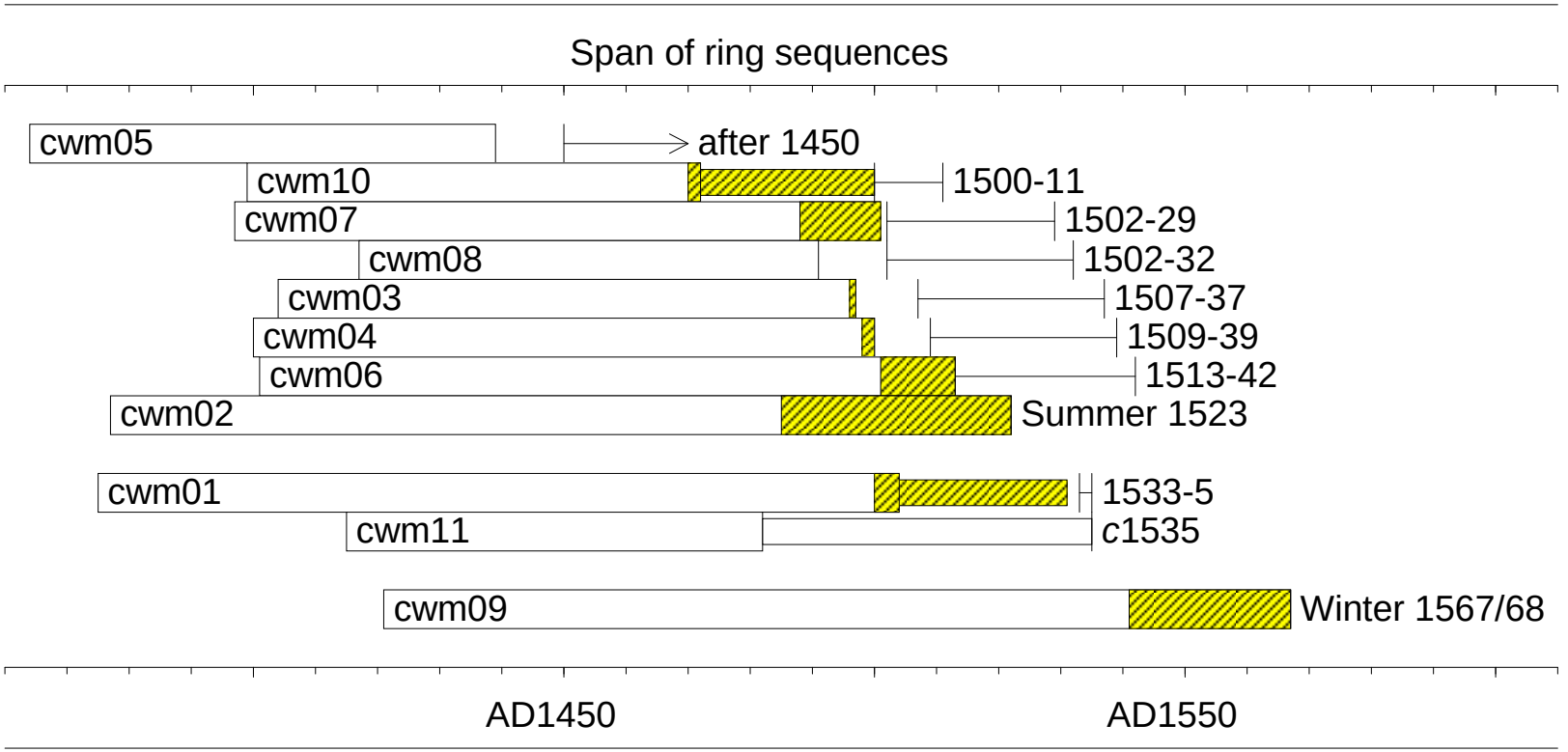

Figure 2: Bar diagram showing the relative positions of overlap of the dated series, along with their interpreted likely, or actual, felling date ranges. Hatched yellow sections represent sapwood rings, and narrow sections of bar represent additional unmeasured rings

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